Abstract

SULFUR TRIOXIDE (SO_3) ISSUES AT TVA'S CUMBERLAND FOSSIL PLANT (CUF)

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TVA's CUF is a two-unit, base load, coal-fired power plant located on the Cumberland River west of Nashville Tennessee. Each of these cell-burner-type units is rated at about 1,300 MW; burns a high sulfur (3 percent), Western Kentucky, bituminous coal; and generates a flue gas containing relatively "high" levels of both sulfur dioxide (SO_2) and SO_3. These two units at the CUF were retrofitted with new, high-efficiency ESPs in the 1980's and highefficiency limestone scrubbing flue gas desulfurization (FGD) systems in 1994 to meet increasingly stringent air emission standards. The latter FGD systems were installed to dramatically (95 percent) decrease the SO_2 emissions in response to the Phase I SO_2 regulations under the Clean Air Act Amendments of 1990. However, soon after the installation and initial operation of these high-efficiency FGD systems, "visible emissions" were reported by the plant's neighbors.

During 1996, IVA formed independent task teams to address two separate issues of concern at the CUF. One task team evaluated the plugging in the boiler air heaters, which had been a problem for some time. This plugging resulted in a gradual increase in the pressure drop and thus, station service electrical consumption over time until the unit could be brought off-line for a thorough cleaning of the air heaters. The second task team evaluated the "visible emissions" that were particularly noticeable under certain meteorological conditions after the new FGD systems were installed.
At the conclusion of both studies, the pressure of SO_3 in the flue gas was found to be either the root cause or a major contributing factor for both of these problems. The task team addressing the air heater plugging problem found the flue gas SO_3 to be the root cause of that problem. The rotary-type air heaters result in relatively "cold" metal baskets moving from the combustion air stream into the flue gas stream with relatively "high" SO_3 levels (25 ppm). Since the surfaces of the metal air heater baskets were well below the sulfuric acid dewpoint of flue gas, the SO_3 was condensing onto these metal surfaces to form liquid sulfuric acid. The alternating cold and hot environments experienced by the baskets allowed both the formation of the liquid sulfuric acid (which then collected fly ash) and the baking of these deposits in the hot flue gas from the economizer. Over time the production of these solid deposits increased the pressure drop across the air heater leading to increases in the station service for the induced draft fans.

The task team addressing the "visible emissions" problem also found the presence of SO_3 in the flue gas was a major contributor to the near-stack visible emissions. As the flue gas is quenched in the new FGD system to a temperature well below the sulfuric acid

dewpoint, the gaseous SO_3 self-nucleates to form a submicron mist of sulfuric acid droplets. Most of these tiny droplets pass through the FGD system uncollected and are discharged from the stack. Unfortunately, these submicron sulfuric acid droplets are in the right size range to readily refract visible light. Even though the actual mass emissions of these droplets are extremely low, the resulting light-scattering is seen as “opacity”, which may be a concem to regulators. It should be noted that both units at the CUF have an opacity monitor upstream of the FGD system that indicates consistently low levels, demonstrating that the “visible” emissions are not due to :high” fly ash emissions. The design of the FGD system, i.e., with a wet stack, also contributed to the “visible emissions” because of the lack of both thermal buoyancy and the discharge momentum, which results in a plume that tends to “hang together” rather than being dispersed under low wind conditions.